

layer, are aligned antiparallel to each other in a ferrimagnetic state. With this arrangement, the plurality of the soft magnetic thin films alternate between the one having magnetization thereof aligned in the direction of a magnetic field generated from the bias layer and the one having magnetization thereof in 180 degrees opposite direction from the direction of the magnetic field of the bias layer.

[0027] The soft magnetic thin film having a magnetization direction thereof 180 degrees opposite from the direction of the magnetic field of the bias layer is subject to disturbance in magnetization direction on both end portions magnetically coupled with the bias layer. The soft magnetic thin film, separated from the above soft magnetic thin film by the nonmagnetic material layer, and having a magnetization direction thereof aligned with the direction of the magnetic field of the bias layer, is disturbed along therewith in magnetization direction on both end portions.

[0028] Both end portions where the soft magnetic thin films constituting the free magnetic field are disturbed in magnetization direction become insensitive regions which present a poor reproduction gain and exhibit no substantial magnetoresistive effect. In the present invention, the electrode layers are formed to extend over the insensitive regions.

[0029] When the free magnetic layer is fabricated by alternately laminating a plurality of soft magnetic thin films having different magnetic moments and nonmagnetic material layers with one nonmagnetic layer interposed between two adjacent soft magnetic thin films, the magnetic coupling junction between the multilayer film and the bias layer is preferably fabricated of an interface of the bias layer with the end face of only one of the plurality of the soft magnetic thin films forming the free magnetic layer.

[0030] It is sufficient if the bias layer aligns the magnetization direction of one of the plurality of the soft magnetic thin films constituting the free magnetic layer. When the magnetization direction of the one soft magnetic thin film is aligned in one direction, another soft magnetic thin film next to the first soft magnetic thin film is shifted to a ferrimagnetic state with a magnetization direction thereof aligned antiparallel. Consequently, all soft magnetic thin films are alternately aligned parallel to and antiparallel to one direction, and the magnetization direction of the entire free magnetic layer is aligned in one direction.

[0031] If the bias layer is magnetically coupled with the plurality of the soft magnetic thin films constituting the free magnetic layer, the magnetization direction of the soft magnetic thin films is undesirably disturbed on both end portions.

[0032] The pinned magnetic layer is fabricated by alternately laminating a plurality of soft magnetic thin films having different magnetic moments and nonmagnetic material layers with one nonmagnetic layer interposed between two adjacent soft magnetic thin films. When the magnetization direction of one soft magnetic thin film, separated from another soft magnetic thin film by the nonmagnetic material layer, is in a ferrimagnetic state with a magnetization direction thereof aligned antiparallel, the plurality of the soft magnetic thin films constituting the pinned magnetic layer mutually pin each other. As a result, the magnetization direction of the pinned magnetic layer is advantageously stabilized in one direction.

[0033] Here again, the magnitude of the magnetic moment of the soft magnetic thin film is the product of the saturation magnetization (M_s) and the film thickness (t) of the soft magnetic thin film.

[0034] The nonmagnetic material layer is preferably made of a material selected from the group consisting of Ru, Rh, Ir, Cr, Re, Cu, and alloys thereof.

[0035] The antiferromagnetic layer is preferably made of a PtMn alloy. Alternatively, the antiferromagnetic layer may be made of an X—Mn alloy where X is a material selected from the group consisting of Pd, Ir, Rh, Ru, and alloys thereof, or may be made of a Pt—Mn—X' alloy where X' is a material selected from the group consisting of Pd, Ir, Rh, Ru, Au, Ag, and alloys thereof.

[0036] According to a third aspect of the present invention, a magnetoresistive-effect device includes a multilayer film including a magnetoresistive-effect layer, a soft magnetic layer, and a nonmagnetic layer with the magnetoresistive-effect layer and the soft magnetic layer laminated with the nonmagnetic layer interposed therebetween, a pair of hard bias layers deposited on both sides of the multilayer film, and a pair of electrode layers respectively deposited on the hard bias layers, wherein the electrode layers extend over the multilayer film.

[0037] Preferably, the magnetoresistive-effect device preferably includes the multilayer film including the magnetoresistive-effect layer, the soft magnetic layer, and the nonmagnetic layer with the magnetoresistive-effect layer and the soft magnetic layer laminated with the nonmagnetic layer interposed therebetween, the pair of hard bias layers deposited on both sides of the multilayer film, and the pair of electrode layers respectively deposited on the hard bias layers, wherein the multilayer film includes a central sensitive region which provides an excellent reproduction gain, exhibiting a substantial magnetoresistive effect and insensitive regions which are formed on both sides of the sensitive region, and provide a poor reproduction gain, exhibiting no substantial magnetoresistive effect, and wherein the electrode layers deposited on both sides of the multilayer film extend over the insensitive regions of the multilayer film.

[0038] Preferably, the position of at least one of the top edge and the bottom edge of the magnetic coupling junction between the multilayer film and the bias layer in the direction of the movement of a medium is at the same level as the position of at least one of the top surface and the bottom surface of the free magnetic layer or the magnetoresistive-effect layer in the direction of the movement of the medium.

[0039] Preferably, the bias layer is magnetically coupled, directly or via another intervening layer as an underlayer, with the multilayer film on the side face thereof transverse to the direction of a track width. The bias layer functions to align the magnetization direction of the free magnetic layer or the magnetoresistive-effect layer, out of the multilayer film, in one direction. It is therefore sufficient if the bias layer is magnetically coupled with the free magnetic layer only or the magnetoresistive-effect layer only. To prevent the magnetic field generated from the bias layer from affecting the magnetization direction of the pinned magnetic layer, the bias layer preferably remains magnetically uncoupled with the pinned magnetic layer.